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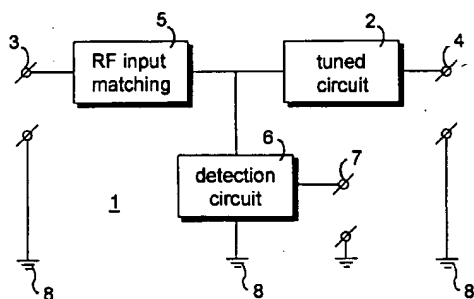
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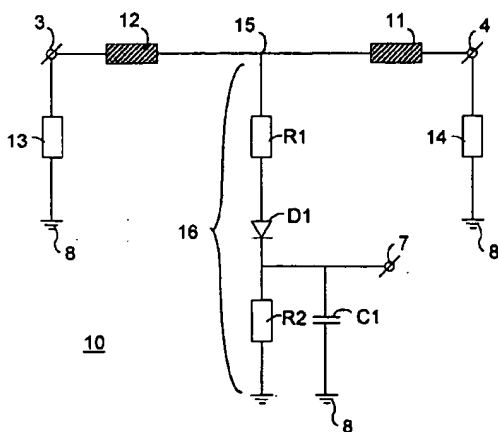
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(54) Title: AN RF ANTENNA DETECTOR CIRCUIT



(57) Abstract: An RF antenna detector circuit (1), comprising a tuned circuit (2), having a first end comprising an RF power input terminal (3) and a second end comprising an antenna output terminal (4), and a detection circuit (6) connected to the tuned circuit (2). The tuned circuit (2) is arranged for producing, during operation, a specific RF signal level to be detected by the detection circuit (6) in the case of a failure of an antenna connected to the antenna output terminal (4).



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Title

An RF antenna detector circuit

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Field of the Invention

The present invention relates to telecommunications systems and, more specifically, to equipment for transmitting and receiving radio communication signals.

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Background of the Invention

Modern radio transceiver devices for use in mobile and cordless telecommunications systems, such as the well-known cellular GSM (Global System for Mobile communication) and DECT (Digital Enhanced Cordless Telecommunications), for example, comprise highly sensitive semiconductor technology.

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Transmitters of radio base stations or radio access units and portable radio terminals or radio communication units, such as radio telephones, comprise transmitters having RF transistor power amplifiers for transmitting RF power into antenna means connected to the power amplifier.

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However, if the antenna means are not connected, the power amplifier can be destroyed due to excessive heat dissipation in the power amplifier during operation.

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To avoid damaging of the power amplifier, in practice, at the output of the RF power amplifier Voltage Standing Wave Ratio (VSWR) measurements are performed. As is generally known by those skilled in the art, in the case of a proper impedance matched antenna connected to the RF power amplifier, the reflected wave energy is almost zero. Accordingly the VSWR, which is the ratio between the reflected wave and the incident wave provided by the RF power amplifier, is almost zero if the antenna is properly connected. In all other cases higher VSWR values will be measured.

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Thus, by measuring the VSWR it can be detected whether an antenna is connected to the power amplifier or not. However, for use in radio access units and radio communication units, for which the

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commercial drivers, among others, are cost and size reduction, VSWR measurement circuitry are too expensive and too voluminous.

Summary of the Invention

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It is an object of the present invention to provide an RF antenna detector circuit, which is of a simple, less expensive and less space consuming construction. In particular for use in radio communications equipment such as a radio access unit and radio communication unit for mobile or cordless radio communication systems.

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It is a further object of the present invention to provide a radio access unit and a radio communication unit for use in radio communications systems, comprising such an RF antenna detector circuit in order to avoid destruction of the RF power amplifier if during operation the antenna means are not or not properly connected.

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According to the present invention, there is provided an RF antenna detector circuit, comprising a tuned circuit, having a first end comprising an RF power input terminal and a second end comprising an antenna output terminal, and a detection circuit connected to the tuned circuit, wherein the tuned circuit is arranged for producing, during operation, a specific RF signal level to be detected by the detection circuit in the case of a failure of an antenna connected to the antenna output terminal.

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Contrary to VSWR measurement, the RF antenna detector circuit according to the invention is arranged for producing a specific RF signal level in the absence of an antenna connected to the antenna output terminal, for example. By detecting the presence of this RF signal level with the detection circuit provided, the absence of the antenna means can be simply established without having to perform ratio calculations and thelike.

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In a preferred embodiment of the RF antenna detector circuit according to the invention, the tuned circuit is a quarter-wave transmission line circuit with respect to the RF operating frequency, wherein the detection circuit is arranged for detecting a low RF signal level or a signal dip.

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For use with modern radio communications devices operating in the Gigahertz range, the transmission line circuit is preferably a quarter-wave stripline circuit.

5 In an embodiment of the RF antenna detector circuit according to the invention, the voltage detection circuit comprises a rectifying element, wherein a first end of the rectifying element connects to the first end of the tuned circuit and a second end of the rectifying element provides a DC output terminal producing, during operation, a DC voltage dependent on the RF voltage level detected at the first end of
10 the tuned circuit.

In a preferred embodiment of the invention, the detection circuit comprises a series connection of a resistor, a rectifying diode and a low pass filter circuit, such as a parallel circuit of a resistor and capacitor, for producing a smoothened DC voltage at the DC
15 output terminal.

In order to avoid damages to a power amplifier connected to the RF power input terminal of the RF antenna detector circuit in the case of absence of or a failure in an antenna connected to the antenna output terminal, in a further embodiment of the invention, an inhibit
20 circuit is provided for inhibiting RF power to be applied by the RF power amplifier to the RF power input terminal at the detection of the specific RF signal level.

The inhibit circuit may be arranged for switching off the RF power amplifier by detecting a low voltage or voltage dip at the
25 DC output terminal of the RF antenna detector circuit in the absence of an antenna connected to the antenna output terminal, for example.

The invention further relates to a radio access unit and a radio communication unit of a radio communication system for wireless telecommunication, comprising transmitter, receiver and control means
30 arranged for providing radio communication in accordance with a wireless radio communications standard, such as GSM or DECT, wherein the transmitter means comprise an RF antenna detector circuit as disclosed above, in particular comprising an inhibit circuit operative to inhibit a power amplifier (PA) of the transmitter means to transmit RF power to the RF
35 antenna detector circuit.

The above-mentioned and other features and advantages of the invention are illustrated in the following description with reference to the enclosed drawings.

5 Brief Description of the Drawings

Figure 1 shows a general block diagram of an RF antenna detector circuit according to the invention.

10 Figure 2 shows a preferred embodiment of the RF antenna detector circuit according to the invention.

Figures 3a and 3b show, in a schematic and illustrative manner, wave patterns at the tuned circuit of figure 2, with and without an antenna connected to the antenna output terminal, respectively.

15 Figure 4 shows a simplified block diagram of radio equipment provided with an RF antenna detector circuit according to the invention, for use in a radio communications system for wireless telecommunication.

20 Detailed Description of the Embodiments

Figure 1 shows a general block diagram of an RF antenna detector circuit 1 according to the invention. The RF antenna detector circuit 1 comprises a tuned circuit 2, a first end of which connects to an RF power input terminal 3 and a second end of the tuned circuit 2 connects to an antenna output terminal 4.

25 Among others for impedance matching purposes, in the RF antenna detector circuit 1 shown, an RF input matching circuit 5 is connected between the RF power input terminal 3 and the first end of the tuned circuit 2.

30 The RF antenna detector circuit 1 further comprises a detection circuit 6, connected to the tuned circuit 2, for example to the first end thereof. The detection circuit 6 comprises a detection signal output terminal 7.

35 In the block diagram of the RF antenna detector circuit 1 shown in figure 1, the relevant input and output signals at the respective input and output terminals relate to a common signal ground 8, indicated by short parallel lines. However, those skilled in the art

will appreciate that the circuit may also comprise input and output terminals, not having a common signal ground.

According to the invention, the tuned circuit 2 is arranged such that in the absence or a failure of an antenna connected to the antenna output terminal 4 a predefined RF signal level appears at the point at which the detection circuit 6 connects. That is, in the embodiment shown, the first end of the tuned circuit 2. By detection of this specific RF signal level, the detection circuit 6 provides an appropriate output signal at its detection signal output terminal 7.

For the purpose of the present invention, the output signal at the detection signal output terminal 7 can be applied to prevent damages to an RF power amplifier (not shown) connected to the RF power input terminal 3 of the RF antenna detector circuit 1. For example by inhibiting RF power to be fed into the RF antenna detector circuit 1 by switching off the power amplifier.

Figure 2 shows a preferred embodiment of the antenna detector circuit according to the invention, designated by reference numeral 10. In the embodiment shown, the tuned circuit 2 comprises a quarter-wave ($\lambda/4$) transmission line circuit 11 at the RF operating frequency, such as a quarter-wave stripline circuit for use in transmitter equipment operating at or near the GHz frequency range. The RF input matching circuit 5 likewise comprises a transmission line circuit 12, such as a stripline circuit. The length of the transmission line circuit 12 at the RF operating frequency is not critical and mainly chosen in order to optimize RF power transfer from a power amplifier 13, connected to the RF power input terminal 3, to antenna means 14 connected at the antenna output terminal 4 of the detector circuit 10. For the purpose of clarity, the power amplifier 13 and the antenna means 14 are represented by their impedances at the RF operating frequency of interest.

At the junction 15 between the transmission line circuits 11 and 12 a detection circuit 16 connects to signal ground 8. The detection circuit 16 comprises a series circuit of a resistor R1, a rectifying diode D1 and a Low Pass (LP) filter comprised by a parallel circuit of a resistor R2 and a capacitor C1. At the junction of the rectifying diode D1 and the LP filter R2//C1, the detection signal output terminal 7 connects.

The rectifying diode D1 is of the type for rectifying RF signals, whereas the resistor R1 is selected in order to minimize RF transmission power loss into the detection circuit 16.

5 The operation of the RF antenna detector circuit 10 will now be explained with reference to figures 3a and 3b.

It is assumed that the transmission lines 11, 12 and the power amplifier 13 and antenna means 14 are impedance matched in order to achieve maximum RF power transfer from the RF power amplifier 13 into the antenna means 14.

10 If an antenna is connected to the antenna output terminal 4, substantially all RF power produced by the power amplifier 13 will be dissipated in the antenna 14 and, accordingly, radiated by the antenna 14. A travelling wave pattern will exist on the quarter-wave transmission line 11, as indicated by a travelling wave 18. See figure 15 3a.

In the absence of an antenna connected to the antenna output terminal 4, the transmission line 11 will be open at its second end. As a result, a standing wave pattern will exist on the transmission line 11, as indicated by reference numeral 19 in figure 3b.

20 The standing wave pattern 19 reaches a maximum in the RF signal voltage at the antenna output terminal 4 and a null or minimum or dip 20 in the RF signal voltage at a point $\lambda/4$ backwards from the antenna output terminal 4. That is, at the first end of the transmission line circuit 11, at a distance $\lambda/4$ backwards from the second end of the transmission line circuit 11. By measuring the RF voltage at the first 25 end of the transmission line circuit 11, i.e. junction 15 in figure 1, absence or failure of the antenna means 14 is directly detected.

Those skilled in the art will appreciate that λ is the wavelength of the RF electromagnetic radiation by the antenna 14. For radio 30 communication equipment operating at a radio frequency band, the transmission line 11 is tuned to the midfrequency of the radio frequency band, for example.

In the circuit of figure 2, in the case of a travelling wave pattern 18 over the transmission line 11 as shown in figure 3a, a 35 DC voltage will be produced at the detection signal output terminal 7, equivalent to the RF voltage at the first end of the transmission line circuit 11 rectified by the rectifying diode D1 and smoothened by the LP

filter provided by the parallel connection of resistor R2 and capacitor C1. In the case of a standing wave pattern 19, as illustrated in figure 3b, the DC voltage produced at the detection signal output terminal 7 of the detection circuit 10 will have a value less than the DC voltage produced for a travelling wave pattern 18, that is with an antenna connected to the antenna output terminal 4.

Accordingly, by detection of a low DC voltage at the signal output terminal 7 of the detection circuit 10, the absence or failure of an antenna at the antenna output terminal 4 of the RF antenna detector circuit 10 is automatically detected.

The circuit shown in figure 2 is a very simple design requiring just a few components and, for example, a stripline 2 provided on a Printed Circuit Board (PCB) (not shown).

Accordingly, the RF antenna detector circuit according to the invention is less space and cost consuming, and excellent to use in modern radio equipment for mobile and cordless radio communication.

Figure 4 shows a simplified block diagram of radio communication equipment, such as a radio access unit, a radio relay unit or a radio communication unit for use in radio communications systems operating following a radio telecommunication standard such as the well-known analog and digital radio telephone standards designated AMPS, ETACS, NMT, GSM, CTO, CT1, CT2, CT3, PHS and DECT, for example.

The communication equipment 21 comprises transmitter means (Tx) 22, receiver means (Rx) 23, control means (C) 24 and further processing and input/output means 25, arranged for further processing of speech and data signals received from the receiver means 23 or to be transmitted by the transmitter means 22. In the case of a portable radio telephone, for example, the means 25 comprise audio amplifier, microphone and loudspeaker means, for example. In the case of a radio access unit, such as a radio base station, the means 25 comprise processor means for processing the relevant speech and data signals for communication purposes.

The control means 24 are arranged to connect antenna means 26 to either the transmitter means 22 or the receiver means 23 by operation of switching means 27, such as semiconductor switching means.

In accordance with the present invention, between the switching means 27 and the antenna means 26 an RF Antenna Detector Circuit 28 is connected, comprising an RF antenna detector circuit 1 or 10

disclosed above. At the detection signal output terminal 7 of the antenna detector circuit 28 an inhibit circuit (I) 29 connects, a control output 30 of which controls the operation of the transmitter means 22. The inhibit circuit 29 is arranged to inhibit RF power to be applied to the RF power input terminal 3 of the antenna detector circuit 28 if the absence or failure of antenna means 26 at the antenna output terminal 4 is detected. This, for example, by switching off the power amplifier of the transmitter means 22.

The inhibit circuit 29 may comprise a simple flip flop circuit or the like, providing a control signal if the voltage level at the detection signal output terminal 7, during operation, is below a set value. This, in order to avoid damaging of the power amplifier of the transmitter means 22.

Although the invention is particularly disclosed for a tuned circuit taking the form of a quarter-wave transmission line, those skilled in the art will appreciate that other tuned circuits can be applied providing a specific RF signal level in the absence of an antenna load.

With respect to the theory of electromagnetic radiation on transmission line circuits, reference is made to the "Antenna Engineering Handbook", third edition, McGraw-Hill.

The invention is further not limited to its use in radio base station or radio access equipment, radio relay equipment and/or radio communication terminal equipment for use in mobile or cordless radio communications systems.

Claims

1. An RF antenna detector circuit, comprising a tuned circuit, having a first end comprising an RF power input terminal and a second end comprising an antenna output terminal, and a detection circuit connected to said tuned circuit, wherein said tuned circuit is arranged for producing, during operation, a specific RF signal level to be detected by said detection circuit in the case of a failure of an antenna connected to said antenna output terminal.
2. An RF antenna detector circuit according to claim 1, wherein said tuned circuit is a quarter-wave transmission line circuit, and said detection circuit is arranged for detecting a low RF signal level or a signal dip at said first end of said tuned circuit.
3. An RF antenna detector circuit according to claim 2, wherein said quarter-wave transmission line circuit is a quarter-wave stripline circuit.
4. An RF antenna detector circuit according to claim 1, 2 or 3, wherein said first end of said tuned circuit connects to said RF power input terminal by an RF input matching circuit.
5. An RF antenna detector circuit according to claim 4, wherein said RF input matching circuit comprises a transmission line circuit, such as a stripline circuit.
6. An RF antenna detector circuit according to any of the previous claims, wherein said detection circuit comprises a rectifying element, a first end of which connects to said first end of said tuned circuit, and a second end of said rectifying element provides a DC output terminal producing, during operation, a DC voltage dependent on the RF voltage level at said first end of said tuned circuit.
7. An RF antenna detector circuit according to claim 6, wherein said detection circuit comprises a series connection of a resistor, a rectifying diode and a low pass filter circuit for producing a smoothened DC voltage at the DC output terminal.
8. An RF antenna detector circuit according to any of the previous claims, further comprising an inhibit circuit, connected to said detection circuit, for inhibiting RF power to be applied to said RF power input terminal at the detection of said specific RF signal level.

9. A radio access unit of a radio communications system for wireless telecommunication, comprising transmitter, receiver and control means, arranged for providing radio communication in accordance with a wireless radio communications standard, said transmitter means
5 comprise an RF antenna detector circuit according to any of the claims 1-8.

10. A radio access unit according to claim 9 comprising an inhibit circuit according to claim 8, wherein said inhibit circuit is operative to inhibit a Power Amplifier (PA) of said transmitter means to
10 transmit RF power to said RF antenna detector circuit.

11. A portable radio communication unit of a radio communications system for wireless telecommunication, comprising transmitter, receiver and control means, arranged for providing radio communication in accordance with a wireless radio communications standard,
15 said transmitter means comprise an RF antenna detector circuit according to any of the claims 1-8.

12. A portable radio communication unit according to claim 11 comprising an inhibit circuit according to claim 8, wherein said inhibit circuit is operative to inhibit a Power Amplifier (PA) of said transmitter
20 means to transmit RF power to said RF antenna detector circuit.

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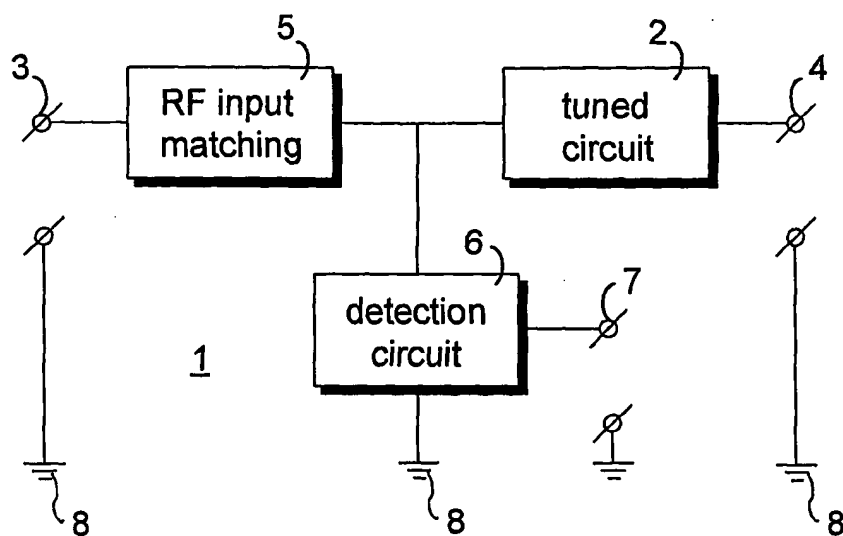


Fig. 1

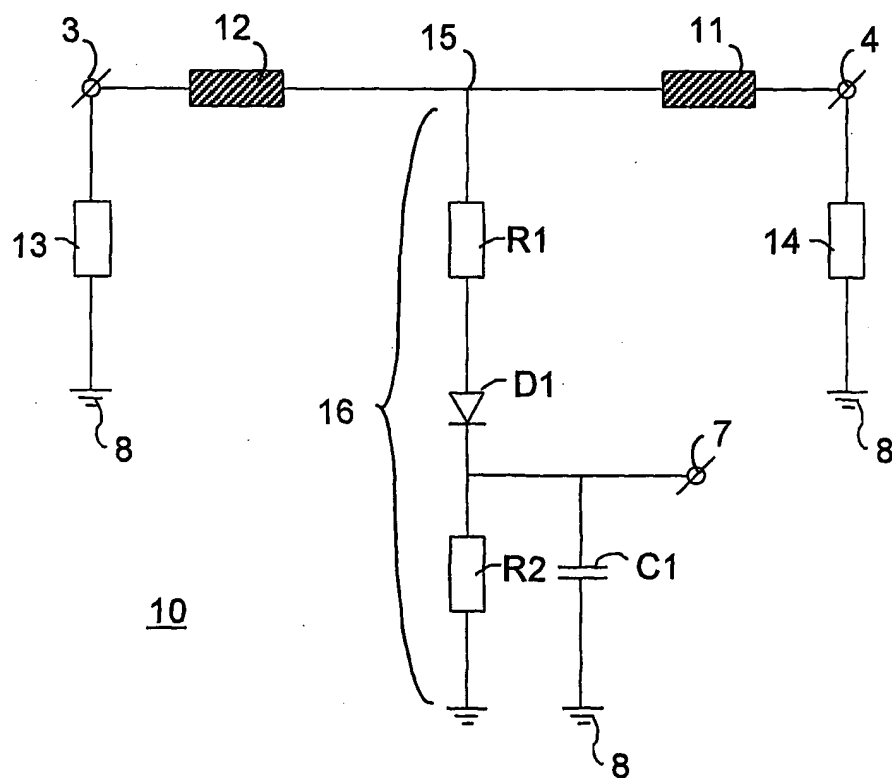


Fig. 2

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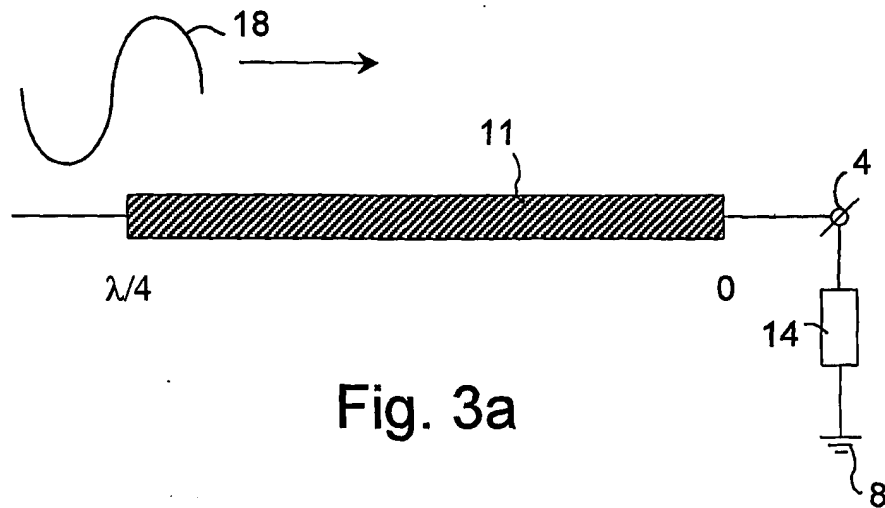


Fig. 3a

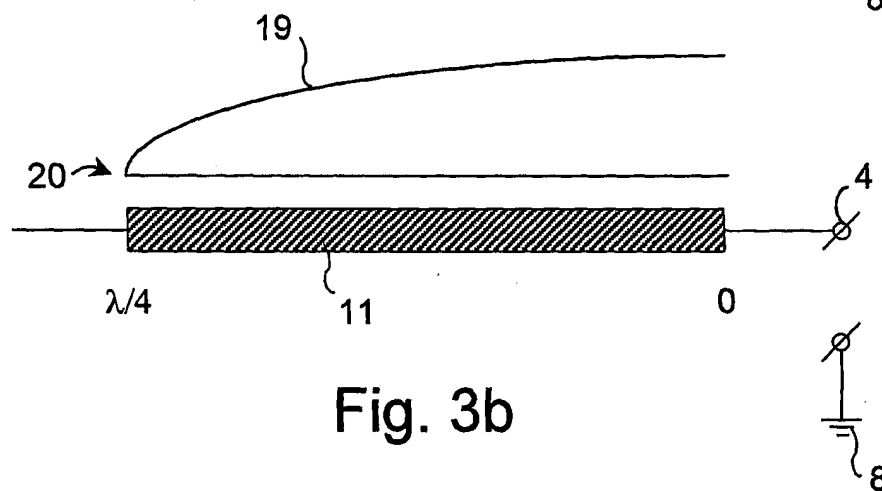


Fig. 3b

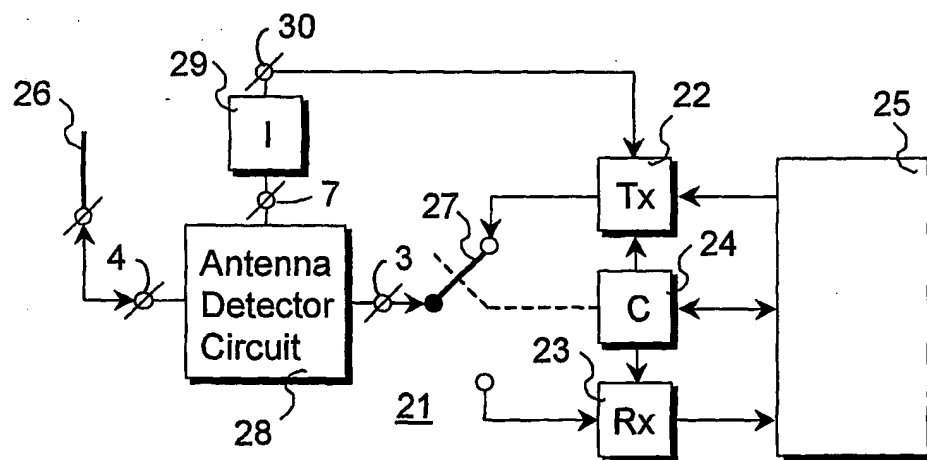


Fig. 4

INTERNATIONAL SEARCH REPORT

Inter Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01Q23/00 H04B17/00 G01R29/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5 590 415 A (PELTOLA ET AL.) 31 December 1996 (1996-12-31) column 2, line 25 - line 62 column 3, line 7 - line 61; figures 1,2 --- -/--	1,9,11



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Inter al Application No

PCT/EP 00/00206

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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